Space Weather Technical Forecast

Issued on Thursday, 09 February 2023 at 13:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares (R1/R2 Radio Blackouts) likely. Active fluence expected to develop in next 24 hours.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with several M-class flares observed. There are seven numbered and two unnumbered sunspot regions on the visible disc. The Peak flare was the M3.1 event at 09/0310 UTC from AR3217 which is emerging across the southeastern limb. This region is the second largest and continues to develop. It retains a beta-gamma magnetic field. The largest region on the disc presently is located in the northern hemisphere, AR3213 and is classified as Eki/Beta delta and has also given some M-class flares No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds are generally elevated with Earth in the fast wind from coronal holes 74 and 75. Observed speeds at L1 were generally 500-600 km/s. The density of the solar wind has been near or slightly below average. Total IMF strength, Bt, was Weak to briefly Moderate, with a peak value of 9T at 09/0305 UTC. The north-south component Bz, was variable, but more generally southward directed ranging -8nT to +7 nT. Phi angle was rather variable and mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3), with an Active interval (Kp 4) 09/0300-09/0600 UTC

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at Background levels throughout. The high energy electron flux (greater than 2MeV) measured by GOES-16 was at Moderate to High levels, peaking at 2520pfu at 08/1550 UTC. The associated 24-hour electron fluence was below the Active level, but on a rising trend, with the observed fluence at 09/0000 UTC being 6.46e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a slight chance of High levels being reached, mainly owing to the large sunspots in the northern hemisphere near centre disc, as well as further regions close to the eastern limb during the period.

Solar Wind / Geomagnetic Activity: CMEs which left the Sun on the 5th and 7th, while forecast to miss the Earth, give a low chance of glancing interactions during much of the forthcoming period. Otherwise, ongoing elevated solar winds due to the fast wind enhancement from CH74 and CH75 are forecast to gradually decline with no other coronal hole sourced enhancements anticipated. Quiet to Unsettled geomagnetic activity is expected with a chance of isolated Active intervals. There is a very slight chance of G1/Minor storms.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of rising in response to any significant flares. High energy electron flux is currently Moderate to High. Similar conditions are

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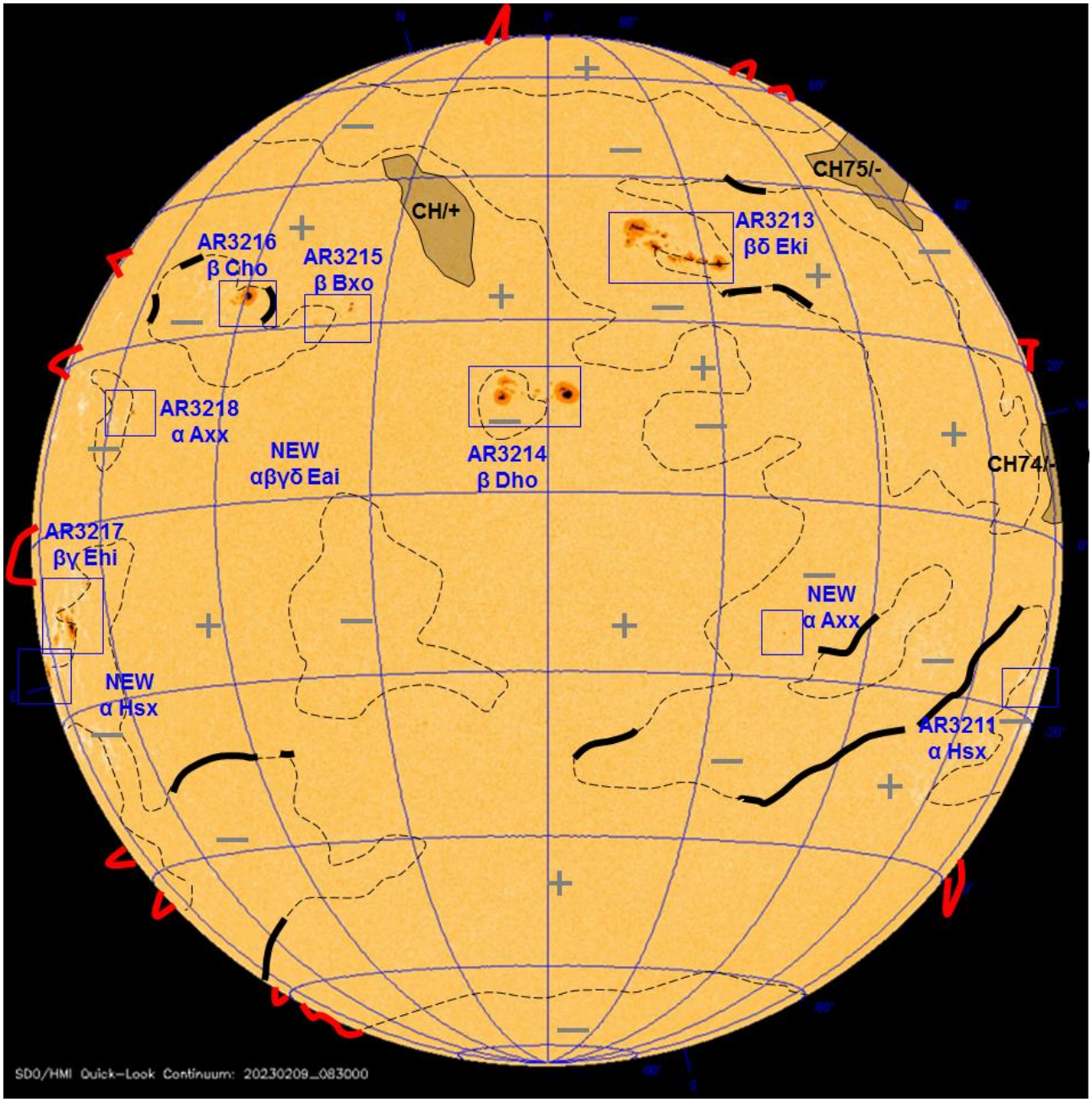
expected for much of the period with a possible declining trend in flux in coming days. The associated 24hr fluence is likely to continue to generally rise, now with the Active threshold (1e8 integrated pfu) expected to be reached over the next 24 hours. In the absence of any significant geomagnetic activity, electron fluence levels may remain close to or above the active threshold in coming days.

Figure 1. Solar Analysis Valid 0800UTC, 9 February 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

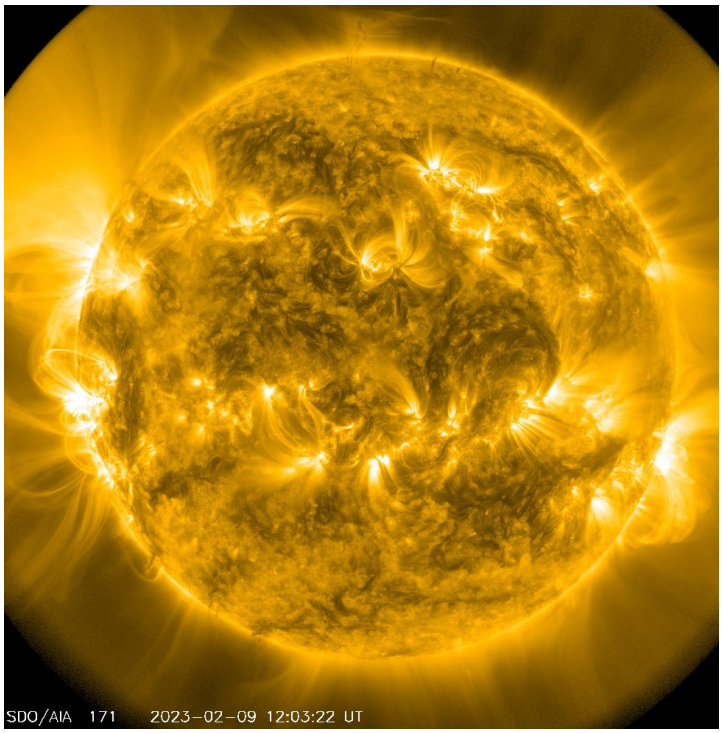
A number of CMEs are expected to miss, but pass close to Earth over the coming several days. These left the Sun on the 5th and 7th Earth is currently experiencing the fast wind from one or both of coronal holes 74 and 75, but will gradually exit from this during the period, with no other new or recurrent features expected. Solar winds, though initially elevated, is predicted to slowly decline on Day 1 (9th), continuing into Day 2 (10th) towards a more background-like state by the end of Day 3 (11th) and probably remaining so into Day 4 (12th). Quiet to Unsettled geomagnetic activity is expected, however given current fast winds and the low confidence CME outlook, Active intervals are possible on all days. There is a very slight chance of G1/Minor Storm intervals at any time during the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: SDO AIA 171 imagery showing magnetic structure on visible disc.



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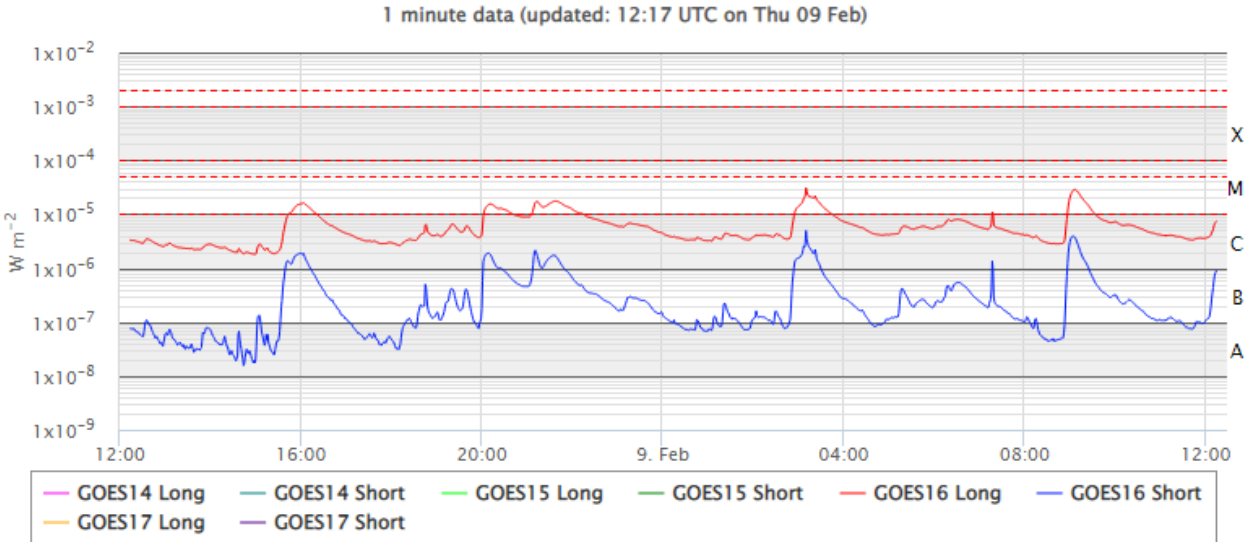
Radio Blackouts - X-Ray Flares:
Moderate activity is likely through the period, with a number of significant active regions on the visible disc. There are seven numbered regions and two unnumbered regions. AR3217 in the far southeast remains the most notable region and continues to grow longitudinally and has produced a couple of M-class flares. AR3213 near centre disc in the northern hemisphere is also active with recent M-class flares both are little changed in recent hours. AR3214 near centre disc in the northern hemisphere is stable and is the second largest active region. Of the new regions rotating on AR3217 appears to be the most developed, and associated with significant looping visible in SDO imagery. Further bright areas of flux are visible on STEREO-A imagery on the eastern limb, indicating the potential for additional areas to rotate onto the visible disc during the coming days. Further M-class flares are likely during the period, with a very slight chance of X-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	60	60
Very Active	R3 to R5 X Class	No	10	10	20	20

Figure 3: X-ray flux over the past 24 hours at GEO with several M-class flares observed.



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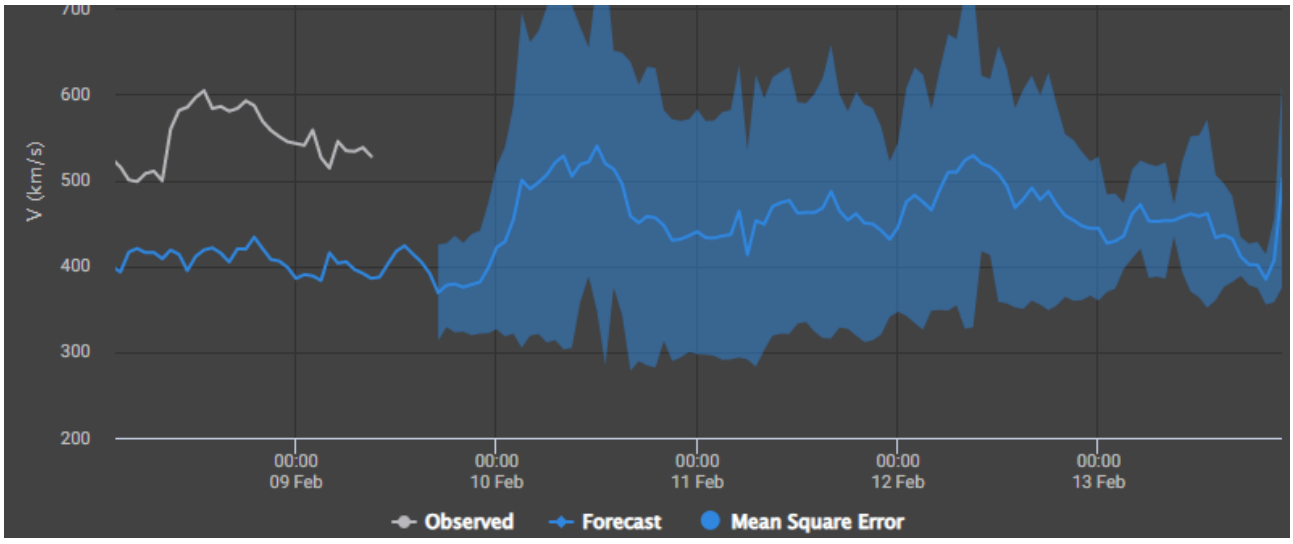
Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux as observed by GOES16 is currently at background levels. No notable high energy proton response was observed from the M-class flares so far, however any further significant flares will give a slight chance of count rates increasing, with a slight chance of reaching the S1 levels

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office Solar Winds Prediction Model (SWPM).



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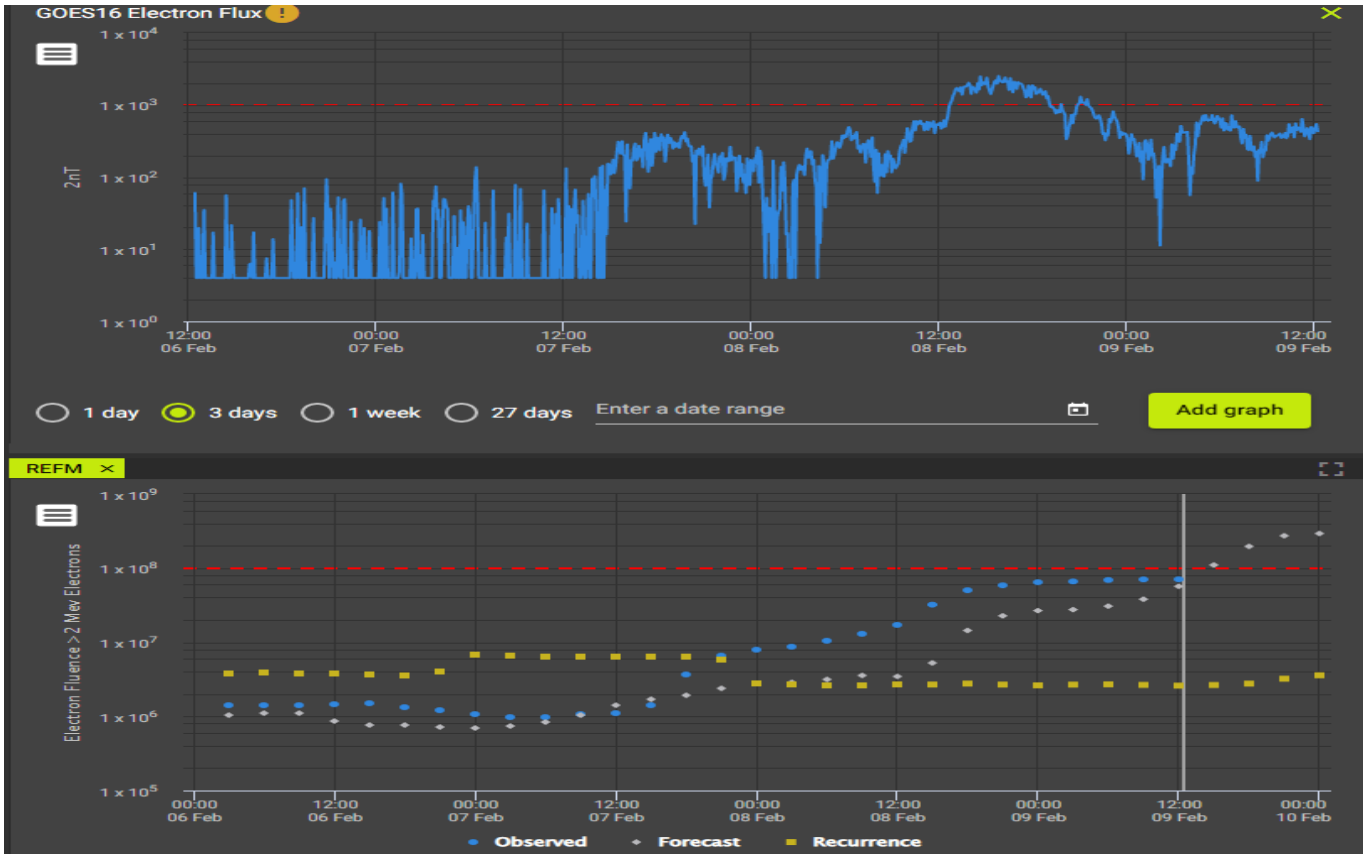
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at Moderate to High levels as a result of the recent slight enhancement to the geospace environment from the arrival of the fast winds from CH74 and CH75. Similar conditions are expected for much of the period.

The associated 24hr fluence is likely to continue to generally rise, and the Active threshold (1e8 integrated pfu) is expected to be reached during the next 24 hours. Met Office REFM output indicates the Active threshold will be reached later on Day 1, but with currently fluence values above this, it gives confidence for an earlier rise above the Active threshold. Beyond T+24 hours the model is less reliable due to its reliance on 27-day persistence which provides a poor comparison to recent conditions. However, in the absence of any significant geomagnetic activity, little change is probable with fluence levels remaining close to our just above the active threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	80	80	60	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output showing increasing trend.



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